

EUROPEAN PATENT APPLICATION

(51) Int Cl.⁷: **G01N 27/419**, G01N 33/00,
E02D 41/14

(22) Date of filing: 30.10.2001

- **Hada, Satoshi**
Kariya-city, Aichi-pref. 448-0029 (JP)
- **Suzuki, Toshiyuki**
Kariya-city, Aichi-pref. 448-0029 (JP)
- **Niwa, Mitsunobu**
Kariya-city, Aichi-pref. 448-0029 (JP)

**(74) Representative: Böckelen, Rainer
Tiedtke-Bühling-Kinne & Partner (GbR),
TBK-Patent
Bavariaring 4
80336 München (DE)**

(72) Inventors:
• Kurokawa, Eiichi
Kariya-city, Aichi-pref. 448-0029 (JP)

(54) **Gas concentration measuring apparatus compensating for error component of output signal**

(57) A gas concentration measuring apparatus is provided which includes a gas concentration sensor consisting of a pump cell, a sensor cell, and a monitor cell. The pump cell works to determine the concentration of O₂. The sensor cell works to decompose an oxygen containing gas such as NO_x and provide an output indicative of the concentration of NO_x. The apparatus also

includes an applying voltage determining circuit which looks up a predetermined voltage-to-current relation to determine a target voltage to be applied to the pump cell as a function of the current produced by the pump cell so as to preclude the pump cell from decomposing the oxygen containing gas component, thereby minimizing an error in determining the concentration of oxygen containing gas as a function of the output of the sensor cell.

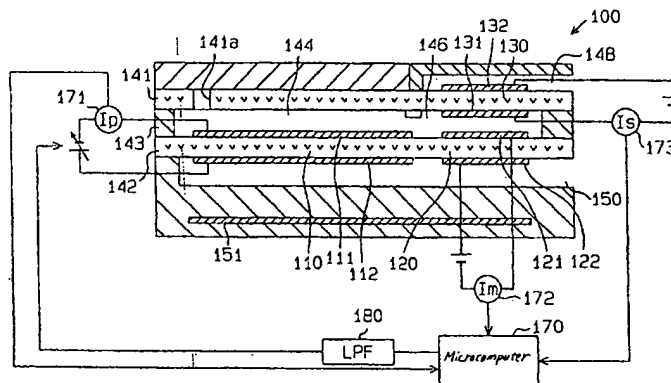


FIG. 1



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 12 5865

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
D,X	EP 0 987 546 A (DENSO CORP) 22 March 2000 (2000-03-22)	1-3	G01N27/419 G01N33/00 F02D41/14
Y	* paragraphs [0019] - [0023], [0025] - [0030], [0034] - [0036], [0040] - [0068], [0143] - [0152] *	7,20-23, 27-29	
A	* figures 5,6,8,9,11,15,29 *	15,24	
D,A	KATO N ET AL: "PERFORMANCE OF THICK FILM NOX SENSOR ON DIESEL AND GASOLINE ENGINES" SAE TRANSACTIONS, JOURNAL OF ENGINES, WARRENDALE, PA, US, 1997, pages 1246-1253, XP000866024 * page 1246 - page 1247; figure 1 * * page 1249, left-hand column *	1,2,5,6, 15,18, 20,23, 24,27	
A	EP 0 851 108 A (DENSO CORP) 1 July 1998 (1998-07-01) * abstract * * column 5, lines 18-36 * * column 7, lines 3-8 * * column 10, line 8 - column 13, line 11 * * column 15, lines 19-23 * * column 16, lines 29-32 * * column 16, line 56 - column 19, line 27 * * figures 1-3,6-12 *	1,3,8-12	TECHNICAL FIELDS SEARCHED (Int.Cl.7) G01N F02D
Y	EP 0 999 442 A (DENSO CORP) 10 May 2000 (2000-05-10)	7,20-23	
A	* paragraphs [0010], [0031] - [0049], [0132] - [0145] * * figures 1,2,5,6,9,10,31,32 *	1-3,15, 18,24,27	
-/--			
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 5 April 2004	Examiner Meyer, F
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 12 5865

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y A	EP 0 841 562 A (NGK SPARK PLUG CO) 13 May 1998 (1998-05-13) * abstract * * column 16, line 17 - column 20, line 54 * * column 22, lines 43-57; figures 1,3,10 *	7,20-22 1,2,4-6, 15,18, 24,27	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
Y	EP 0 878 709 A (NGK SPARK PLUG CO) 18 November 1998 (1998-11-18) * abstract; figure 1 *	7,20-22	
Y	WO 00/57167 A (HITACHI LTD ;SUZUKI SEIKOU (JP); KOMACHIYA MASAHIRO (JP)) 28 September 2000 (2000-09-28) * page 16, line 16 - page 17, line 18 * * figures 10,11 *	7,20-22	
Y	& EP 1 174 712 A (HITACHI LTD) 23 January 2002 (2002-01-23) * paragraph [0040]; figures 10,11 *	7,20-22	
A	EP 0 831 322 A (NGK INSULATORS LTD) 25 March 1998 (1998-03-25) * abstract * * page 1, columns 44-52 *	20-23	
A	US 4 770 760 A (KATO NOBUHIDE ET AL) 13 September 1988 (1988-09-13) * abstract; figure 1 *	20-23	
A	EP 0 903 575 A (RIKEN KK) 24 March 1999 (1999-03-24) * abstract; figure 1 *	20-23	
-/--			
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 5 April 2004	
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after, the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P4/C01)



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 12 5865

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y	EP 0 995 986 A (DENSO CORP)	27-29	
A	26 April 2000 (2000-04-26) * paragraphs [0103] - [0116], [0142] * * figures 21,22 * -----	1,15,20,24	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 5 April 2004	Examiner Meyer, F
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03.82 (P04-001)



European Patent
Office

Application Number
EP 01 12 5865

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- ☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- ☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- ☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:



European Patent
Office

**LACK OF UNITY OF INVENTION
SHEET B**

Application Number
EP 01 12 5865

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-14

2. claims: 15-19,24-26

3. claims: 20-26

4. claims: 27-29

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 01 12 5865

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

05-04-2004

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0987546	A	22-03-2000	JP 2000155109 A	06-06-2000
			EP 0987546 A2	22-03-2000
			US 6383354 B1	07-05-2002
EP 0851108	A	01-07-1998	JP 10185861 A	14-07-1998
			EP 0851108 A2	01-07-1998
			US 5993641 A	30-11-1999
EP 0999442	A	10-05-2000	JP 2000137018 A	16-05-2000
			EP 0999442 A2	10-05-2000
			US 6295862 B1	02-10-2001
			US 2001039825 A1	15-11-2001
EP 0841562	A	13-05-1998	JP 3332761 B2	07-10-2002
			JP 10142194 A	29-05-1998
			EP 1324028 A1	02-07-2003
			EP 0841562 A2	13-05-1998
			US 6214207 B1	10-04-2001
EP 0878709	A	18-11-1998	JP 3372186 B2	27-01-2003
			JP 10267885 A	09-10-1998
			EP 1074833 A1	07-02-2001
			EP 1074834 A1	07-02-2001
			EP 1077375 A1	21-02-2001
			EP 0878709 A2	18-11-1998
			US 2002017467 A1	14-02-2002
			US 2003042151 A1	06-03-2003
			US 2002130053 A1	19-09-2002
			JP 11023528 A	29-01-1999
			JP 3501956 B2	02-03-2004
			JP 11108887 A	23-04-1999
			JP 11148910 A	02-06-1999
WO 0057167	A	28-09-2000	WO 0057167 A1	28-09-2000
			EP 1174712 A1	23-01-2002
			US 6592732 B1	15-07-2003
EP 1174712	A	23-01-2002	WO 0057167 A1	28-09-2000
			EP 1174712 A1	23-01-2002
			US 6592732 B1	15-07-2003
EP 0831322	A	25-03-1998	JP 10090222 A	10-04-1998
			DE 69713698 D1	08-08-2002
			DE 69713698 T2	13-02-2003
			EP 0831322 A2	25-03-1998
			US 6045673 A	04-04-2000

EPO FORM P4459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 01 12 5865

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

05-04-2004

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 4770760	A	13-09-1988	JP 1944307 C	23-06-1995
			JP 6072861 B	14-09-1994
			JP 63038154 A	18-02-1988
			DE 3782584 D1	17-12-1992
			DE 3782584 T2	06-05-1993
			EP 0257842 A2	02-03-1988
EP 0903575	A	24-03-1999	CA 2214571 A1	03-03-1999
			CN 1212369 A	31-03-1999
			JP 3128114 B2	29-01-2001
			JP 9274011 A	21-10-1997
			US 5861092 A	19-01-1999
			EP 0903575 A1	24-03-1999
EP 0995986	A	26-04-2000	JP 2000171439 A	23-06-2000
			EP 0995986 A2	26-04-2000
			US 6453724 B1	24-09-2002

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82